Lunar Atmosphere and Dust Environment Explorer Integration and Test

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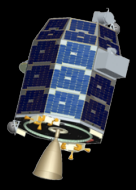
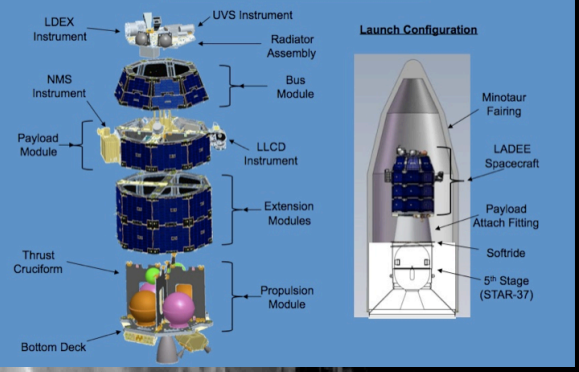


The Lunar Atmosphere and Dust Environment Explorer (LADEE) is a NASA collaborative flight project to explore the lunar exosphere. It is being developed through a unique partnership between NASA's Ames Research Center (ARC) and Goddard Space Flight Center (GSFC). Each center brings its own experience and flight systems heritage to the task of integrating and testing the LADEE subsystems, instruments, and spacecraft. As an "in-house" flight project being implemented at low-cost and moderate risk, LADEE relies on single-string subsystems and protoflight hardware to accomplish its mission.

Integration and test (I&T) of the LADEE spacecraft with the instruments will be performed at GSFC, and includes assembly, integration, functional testing, and flight qualification and acceptance testing. Due to the nature of the LADEE mission, I&T requirements include strict contamination control measures and instrument calibration procedures. Environmental testing will include electromagnetic compatibility (EMC), vibro-acoustic testing, and thermal-balance/vacuum.

Upon successful completion of spacecraft I&T, LADEE will be launched from NASA's Wallops Flight Facility. Launch of the LADEE spacecraft is currently scheduled for December 2012.

LADEE Spacecraft Overview

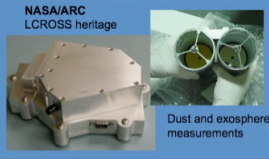


LADEE Instruments

Neutral Mass Spectrometer (NMS)
NASA/GSFC
MSL/SAM Heritage

In situ measurement of exospheric species

UltraViolet Spectrometer (UVS)
NASA/ARC
LCROSS heritage



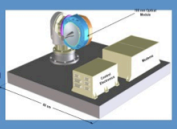
Dust and exosphere measurements

Lunar Dust EXperiment (LDEX)
U.Colorado/LASP
HELIOS, Galileo, Ulysses, and Cassini heritage

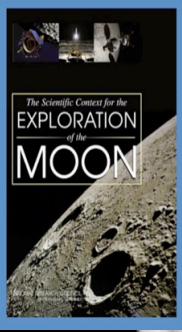
Impact ionization dust detector

Lunar Laser Communication Demonstration (LLCD)
MIT/LLNL

High data rate optical communication technology



LADEE Science Goals



- The top eleven science goals identified in the National Research Council report, "Scientific Context for the Exploration of the Moon" include:
  a. Determine the global density, composition, and time variability of the fragile lunar atmosphere before it is perturbed by further human activity
  b. Determine the size, charge, and spatial distribution of electrostatically transported dust grains and assess their likely effects on lunar exploration and lunar-based astronomy
- Similar objectives outlined in the 2003 NRC Decadal Survey "New Frontiers in the Solar System: An Integrated Exploration Strategy"

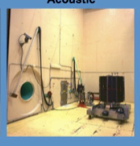
The LADEE mission is designed to begin to address these objectives

- Science requirements:
  - Measure spatial and temporal variations of Ar, He, Na, and K. The temporal scales covered will range from three orbits of the LADEE spacecraft around the Moon to a period of one lunation. The spatial coverage will be sufficient to resolve variations in these exospheric constituents over the terminator regions of the Moon.
  - Detect or obtain new upper limits for other species for which previous observations have been made.
  - Search for other species or positive ambient ions of these species and other atoms or compounds in the 2-150 Da mass range.
  - Detect or set upper limits for the properties of dust using remote sensing occultation observations. These observations will be capable of measuring densities of at least 10^{-4} dust particles/cm^{-3}, for grains 100 nm or larger, over an altitude range of 1.5 to 50 km.
  - Detect or set upper limits on the spatial and size distribution of the dust population at 50 km, over the spatial and temporal scales outlined in requirement

I&T Facilities
at Goddard Space Flight Center

EMC

Acoustic



Vibration

Thermal-Vacuum

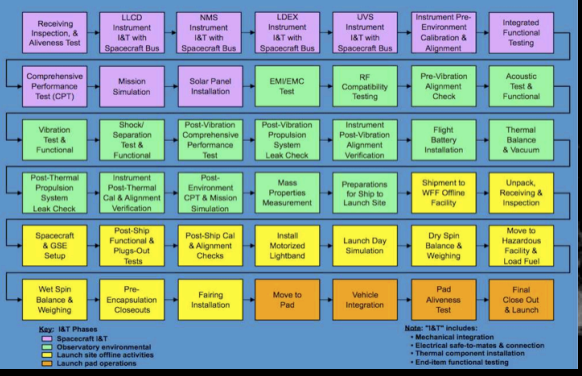
Mass Properties

Encapsulation

Vehicle Integration

Launch Operations

LADEE Spacecraft I&T Flow



LADEE I&T Challenges & Mitigations

Challenge	Mitigation
• Low-cost ("Enhanced" Class-D)	• Streamline procedures, reduced paper • Leverage expertise from both centers (ARC, GSFC) • Thorough planning and preparations • Protoflight test program, with "flatsat" testing
• Strict cleanliness requirement	• 10K cleantent, facilities upgrades • Spacecraft bakeout prior to instrument integration • Procedural controls, personnel training
• No suitable spin-balance table	• Upgrade GSFC's table for explosion-proofing • Arrange for shipping to launch site
• Schedule is short with little slack	• Establish contingencies and flexibility in components • Ensure facilities are available when needed • Reorder I&T sequence if necessary • Plan for single-shift operations; go to multi-shift A/R
• New launch vehicle configuration	• Perform vehicle simulation testing • Ensure interface test procedures well-defined
• Unique intercenter relationship	• Leverage expertise from both centers (ARC & GSFC) • Well-defined roles and responsibilities • Robust communication